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By FENNER A. CHACE, Jr.

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By Fenner A. Chace, Jr.

Clipperton Island, situated in the eastern Pacific Ocean at 10°18′N., 109°13′W. and separated by thousands of miles of open sea from the other coral islands to the west, supports a marine fauna of far greater zoogeographic interest than is indicated by the meager attention that has been devoted to it. There are but three publications (Rathbun, 1902; Schmitt, 1939; and Hertlein and Emerson, 1957) that deal even in part with the decapod crustaceans of Clipperton. A very useful description and historical account of the Island, as well as a bibliography of earlier studies, has been given by Sachet (1960).

Due to the efforts of biologists from the Scripps Institution of Oceanography of the University of California, who visited the Island aboard the *Spencer F. Baird* in 1954, 1956, and 1958, collections are now available for a significant analysis of that fauna. The late Conrad Limbaugh was largely responsible for the fine collections made in 1956 and 1958. Not only the Scripps material, but also that which formed the basis for the Rathbun and Schmitt studies, were examined for the present report. The Scripps collections exactly doubled the number of species of macruran and anomuran decapods previously known from Clipperton, but the efforts of Waldo L. Schmitt, who obtained 11 of the 24 known species in a few hours during the Presidential Cruise of 1938, cannot be minimized. That the fauna is not yet completely known is indicated by the failure of either the Presidential Cruise or the Scripps parties to collect the

single shrimp obtained by the Hopkins Stanford Expedition in 1898 and by the absence from the Scripps collections of two of the shrimps obtained during the Presidential Cruise.

I am very grateful to Conrad Limbaugh and other members of the Scripps Expeditions for placing this interesting material at my disposal. Most of it has been deposited in the national collections; a duplicate set, where available, has been sent to the Museum National d'Histoire Naturelle in Paris. The brachyuran decapods collected by the Scripps Expeditions are being reported upon separately by John S. Garth of the Allan Hancock Foundation, University of Southern California.

In addition to the species listed below, the Scripps collections contained two unidentifiable alpheid shrimps. One is a species of *Automate*, represented by two female or immature specimens lacking most of the pereiopods. The other is a species of the Paulsoni Group of *Synalpheus*, represented by a similarly incomplete specimen.

Family Penaeidae: Subfamily Penaeinae

Metapenaeopsis kishinouyei (Rathbun)

Parapenaeus kishinouyei Rathbun, 1902, p. 288, pl. 12, figs. 13–15.
Penaeopsis kishinouyei Schmitt, 1924, p. 161.
Penaeopsis (*Metapenaeopsis*) *kishinouyei* Burkenroad, 1938, p. 72, figs. 16, 17.—Anderson and Lindner, 1945, p. 310.

Material: East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 1 female.

Measurements: Carapace length, 7.5 mm.

Remarks: This specimen agrees very well with female syntypes of similar size with which it has been compared. In males and immature females, the tips of the rostral teeth form a convex line, as noted by Rathbun, but they form a nearly straight line in mature females. Kubo (1949) and Dall (1957) have been followed in considering *Metapenaeopsis* of generic rather than subgeneric rank.

Distribution: Previously recorded from the Galapagos and Revilla Gigedo Islands.

Family Palaemonidae: Subfamily Palaemoninae

Brachycarpus biunguiculatus (Lucas)

Palaemon biunguiculatus Lucas, 1849, p. 45, pl. 4, fig. 4.
Brachycarpus biunguiculatus Schmitt, 1939, p. 13, fig. 1.—Holthuis, 1952, p. 3, pl. 1.

Material: Northwest shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 1 female.—Poison; October 20, 1956;

W. Baldwin; 1 male, 9 females (8 ovigerous).—October 1956; C. Limbaugh; 1 male.—East side, coral reef; August 9, 1958; Sta. W58–283; Reese, Baldwin, and Wintersteen; 1 male, 3 females.—South shore, coral reef; August 11, 1958; Sta. W58–285; Reese, Limbaugh, Baldwin, and Wintersteen; 4 males, 3 ovigerous females.—Northwest end, reef; August 14, 1958; Sta. W58–288; Reese, Baldwin, and Wintersteen; 1 male, 2 females.—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 13 males, 16 females (11 ovigerous).—South shore, coral reef; August 19, 1958; Sta. W58–295; Reese, Baldwin, and Limbaugh; 1 male.—August 7–26, 1958; Sta. ITP F–1; Reese, Baldwin, and Wintersteen; 1 male.—August 7–26, 1958; C. Limbaugh; 1 male.—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 1 female.—Coral reef, intertidal; August 1958; E. S. Reese; 1 ovigerous female.—Northeast side, reef flat, 0–1 feet at low tide; collected with "Endrin" insecticide; September 13, 1958; Limbaugh, Chess, and Hambly; 2 males, 8 females (7 ovigerous).—Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 2 males.

Measurements: Carapace lengths of males, 3.2–10.8 mm.; of females without eggs, 3.3–7.9 mm.; of ovigerous females, 6.9–11.5 mm.

Remarks: In the smallest specimen, which has a carapace length of 3.2 mm. the appendix masculina on the second pleopods is very short, hardly more than a bud. All 28 of the females with a carapace length of 8.0 mm. or more are ovigerous, whether they were collected in August, September, or October.

Distribution: Red Sea, Ceylon, Wake Island, Hawaii, Bermuda to Curaçao, Liberia, and the Mediterranean. *B. biunguiculatus* may be pantropical, but it has not yet been recorded from the Pacific coast of the Americas.

Palaemon (Palaemon) gladiator Holthuis

Palaemon, sp. Rathbun, 1902, p. 291.
Palaemon ritteri Schmitt, 1924, p. 168. Not *P. ritteri* Holmes, 1895.
Palaemon gladiator Holthuis, 1950, p. 96.
Palaemon (Palaemon) gladiator Holthuis, 1952, p. 178, pl. 44, figs. h–l.

Material: Lagoon; November 23, 1898; Hopkins Stanford Galapagos Expedition; 1 male.

Measurements: Carapace length, 4.7 mm.

Distribution: Otherwise known only from the Galapagos Islands. The numerous specimens of *P. gladiator* that have been taken by several expeditions to the Galapagos Islands, where the Hopkins Stanford Expedition concentrated its activities, and the absence of specimens from collections made subsequently at Clipperton Island might cast some doubt on the validity of the Clipperton record. There is no evidence of mislabeling, however. The limited attention

given to the Clipperton lagoon fauna by recent expeditions may account for the failure to rediscover the species there. Also, there is evidence that the lagoon may have had a higher salinity in 1898 and that it may have had a more extensive fauna than it does at present.

Subfamily Pontoniinae

Harpiliopsis depressus (Stimpson)

Harpilius depressus Stimpson, 1860, p. 38.
Harpiliopsis depressus Holthuis, 1951b, p. 70, pls. 21, 22, figs. a–f.

Material: Northwest end, reef; August 14, 1958; Sta. W58–288; Reese, Baldwin, and Wintersteen; 3 males, 1 ovigerous female.—Intertidal; August 7–26, 1958; E. S. Reese; 1 male.—Northeast transect, 36 feet; August 27, 1958; Chess and Hambly; 1 male, 1 ovigerous female.—Northeast corner, 45 feet; August 30, 1958; Limbaugh and Chess; 1 male.—Coral at 20 to 40 feet; August 1958; Allison and Limbaugh; 3 males, 1 female.

Measurements: Carapace lengths of males, 1.7–3.5 mm.; of female without eggs, 2.2 mm.; of ovigerous females, 2.7–3.7 mm.

Remarks: In the smallest specimen, which has a carapace length of 1.7 mm., the appendix masculina is about half developed.

Distribution: Red Sea and Seychelles to the west coast of the Americas from the Gulf of California to Colombia.

Family Alpheidae

Alpheus lottini Guérin

Alpheus lottini Guérin, 1830–1831, pl. 3.—Holthuis, 1958, p. 22.
Crangon ventrosa Banner, 1953, p. 84, fig. 28.—Hertlein and Emerson, 1957, p. 6.
Alpheus ventrosus Banner, 1958, p. 164, fig. 4.

Material: Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 1 male, 1 ovigerous female.—Northeast corner, 45 feet; August 30, 1958; Limbaugh, Chess, and Hambly; 1 male, 1 ovigerous female.—Coral reef, intertidal; August 1958; E. S. Reese; 1 male.—Coral at 20–40 feet; August 1958; Allison and Limbaugh; 1 male, 2 ovigerous females.—East side, reef flat, margin or ridge, 0–2 feet; September 14, 1958; Limbaugh and Chess; 1 male.—Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 1 ovigerous female.

Measurements: Carapace lengths of males to base of rostrum, 6.7–8.6 mm.; of ovigerous females, 5.6–7.3 mm.

Remarks: There is an excellent discussion of the variation and synonymy of this species in Banner (1958).

Distribution: Red Sea and South Africa to the Gulf of California.

Alpheus clippertoni (Schmitt)

Crangon hawaiiensis clippertoni Schmitt, 1939, p. 11.
Crangon nanus Banner, 1953, p. 90, figs. 30, 31. Not *C. nanus* Krøyer, 1824.
Alpheus nanus Banner, 1956, p. 345; 1957, p. 198.
Alpheus huikau Banner, 1959, p. 139, fig. 5.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9–38; W. L. Schmitt; 5 males, 4 ovigerous females (holotype and paratypes).

MEASUREMENTS: Carapace lengths of males to base of rostrum, 2.4–3.6 mm.; of ovigerous females, 3.0–4.5 mm.

REMARKS: The grooves on the outer surface of the major chela of this species are much more prominent than indicated in the original description. Comparison of this material with the type of *Crangon nanus* leaves little doubt that they belong to the same species. The peculiar form of the pleopods and the broadened third maxillipeds suggest that the species belongs to another genus, possibly *Metalpheus* as intimated by Banner (1953), but it seems best to retain the current combination until more extensive studies of alpheid relationships are made.

DISTRIBUTION: Saipan, Mariana Archipelago; Arno Atoll, Marshall Islands; Raroia Atoll, Tuamotu Archipelago; Hawaiian Islands; and Clipperton Island.

Alpheus paracrinitus Miers

Alpheus paracrinitus Miers, 1881, p. 365, pl. 16, fig. 6.—Holthuis, 1951a, p. 74.
Alpheus paracrinitus var. *bengalensis* Coutière, 1905, p. 901, pl. 32, fig. 37.
Crangon paracrinitus Schmitt, 1939, p. 12.
Crangon paracrinita var. *bengalensis* Banner, 1953, p. 110, fig. 40.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 2 males, 4 ovigerous females.—Poison; October 20, 1956; W. Baldwin; 1 cheliped.

MEASUREMENTS: Carapace lengths of males to base of rostrum, 3.6 and 5.0 mm.; of ovigerous females, 3.5–5.0 mm.

REMARKS: As Schmitt (1939) has pointed out, these specimens "seem to bridge the differences existing between the species proper and its known variety *bengalensis* Coutière." There has now been an opportunity to compare them with an ovigerous female collected by R. Bassindale at Prampram, Ghana, in 1950; the typical form was first described from Senegal. The only apparent difference between the Clipperton material and the West African specimen is the proportionately longer antennal scale in the latter. In the specimens from Clipperton, the spine of the scale reaches about as far as the end of the antennular peduncle and falls far short of the end of the antennal peduncle; in the Ghana specimen, it reaches well beyond the end of the antennular peduncle and nearly as far as the antennal peduncle. On the other hand, Banner (1953) has mentioned

some variation in the proportions of the antennules and antennae in Hawaiian material, and the examination of seven Hawaiian specimens identified by Banner as *Crangon paracrinita bengalensis* has disclosed one specimen in which the antennal scale is nearly as long as it is in the one from Ghana. It is probable, therefore, that only one species is represented by the material examined from the eastern Atlantic and the eastern Pacific, and it is doubtful that Coutière's subspecies will be tenable when more abundant material is available for comparison.

DISTRIBUTION: West Africa and the Indian and Pacific Oceans from the Red Sea to Clipperton Island.

?*Alpheus bouvieri* A. Milne-Edwards

Alpheus bouvieri A. Milne-Edwards, 1878, p. 231.—Coutière, 1905, p. 907, pl. 85, fig. 44.—Holthuis, 1951a, p. 81, fig. 16.

MATERIAL: September 10–15, 1958; C. R. Harbison; 1 male, 1 female.

MEASUREMENTS: Carapace length of male to base of rostrum, 6.3 mm.; of female, 5.9 mm.

REMARKS: The male specimen of this pair has lost the minor cheliped. It is therefore impossible to be certain of the identification. The specimens agree in other respects, however, with Coutière's figures of one of the syntypes of *A. bouvieri* from the Cape Verde Islands and differ from Holthuis's figures of a specimen from the same area in the less prominent rostrum, stouter antennular peduncles, broader major chela, and stouter and differently proportioned carpal segments of the second pereiopods. It seems very doubtful that the specimens figured by these two authors belong to the same species. Only re-examination of the type lot will determine which is the true *A. bouvieri*.

DISTRIBUTION: *A. bouvieri* has been recorded from the West African coast and the offlying island groups, Fernando Noronha off northeastern Brazil, Panama, Djibouti in the Gulf of Aden, and the Maldive Islands. A pantropical distribution is indicated, but the identity of the Atlantic and Pacific specimens will remain uncertain until the type series is re-examined.

Alpheus pacificus Dana

Alpheus pacificus Dana, 1852, p. 544; 1855, pl. 34, fig. 5.
Crangon pacifica Banner, 1853, p. 138, fig. 50.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 2 males, 3 females.—Poison; October 20, 1956; W. Baldwin; 31 males, 20 females (13 ovigerous), 5 juveniles.—East side, coral reef; August 9, 1958; Sta. W58–283; Reese, Baldwin, and Wintersteen; 15 males, 20 females (12 ovigerous),

5 juveniles.—South shore, coral reef, sand; August 11, 1958; Sta. W58–285; Reese, Limbaugh, Baldwin, and Wintersteen; 2 males, 15 females (8 ovigerous), 2 juveniles.—East end, coral reef; August 15, 1958; Sta. W58–289; E. S. Reese; 39 males, 28 females (18 ovigerous), 10 juveniles.—South shore, coral reef; August 19, 1958; Sta. W58–295; Reese, Baldwin, and Limbaugh; 11 males, 7 females (6 ovigerous).—Coral reef, intertidal; August 1958; E. S. Reese; 4 females (3 ovigerous).—Northeast side, reef flat, low tide, 0–1 foot; collected with "Endrin" insecticide; September 13, 1958; Limbaugh, Chess, and Hambly; 25 males, 39 females (34 ovigerous).

Measurements: Carapace lengths of males to base of rostrum 3.6–12.5 mm.; of females without eggs, 3.8–7.8 mm.; of ovigerous females, 5.6–13.1 mm.; of juveniles, 2.2–3.5 mm. Total length of largest male, about 37 mm.; of largest female, about 41.5 mm.

Remarks: Males with carapace lengths ranging from 3.6 to 4.5 mm. have very small appendices masculinae. The smallest ovigerous female, with a carapace length of 5.6 mm., carries only two eggs, and all ovigerous females with carapace lengths of less than 7.1 mm., have few eggs. All 51 females with carapace lengths of more than 7.8 mm., are ovigerous, including those collected in August, September, and October.

Most of the specimens, except the smallest and the largest, have a rather prominent, outstanding tooth on the outer surface of the major chela near the distal margin of the socket in the fixed finger. The few Hawaiian specimens of similar size that have been available for comparison also have this tooth, but it is obscure in the neotype.

Two of the specimens in the present collection are so aberrant that they were first thought to represent a distinct species. One of them, a male with a carapace length of 8.6 mm., from Sta. W58–289, lacks a rostrum and has a very long and narrow major chela; the entire chela is more than two and a half times as long as broad, and the fingers are longer than the palm. The other, a male with a carapace length of 10.2 mm., from Sta. W58–295, has a normal rostrum but an even more elongate major chela; it is more than two and two-thirds times as long as broad, and the fingers are about as long as the palm. These two specimens fall within the normal limits of variation of *A. pacificus* in all other respects, however, so it is probable that they are merely abnormal specimens of that species, even though their correct identification would have been practically impossible had they not been associated with normal specimens. One of the ovigerous females taken on September 13, 1958, has two major chelipeds, the left slightly the larger.

Distribution: Throughout the Indo-Pacific region from the Red Sea and Madagascar to Clipperton Island.

Pomagnathus corallinus Chace

Pomagnathus corallinus Chace, 1937, p. 124, fig. 5.—Schmitt, 1939, p. 12.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 2 males.

MEASUREMENTS: Carapace lengths to base of rostrum, 2.7 and 3.1 mm.

REMARKS: These are apparently the only known specimens of this genus and species, aside from the type. Except for their smaller size, they agree in nearly all respects with the ovigerous female type from Baja California. The inner antennular flagella, which were broken in the type, are fully twice as long as the outer flagella. The appendix masculina on the second pleopods is about half as long as the appendix interna in the smaller specimen, about two-thirds as long in the larger. In the form of the front, the proportions of the antennules and antennae, the form of the chelipeds, and the expanded third maxillipeds, *Pomagnathus* bears an obvious resemblance to *Metalpheus*, which was proposed by Coutière for certain species of *Alpheus* similar to *A. clippertoni*. Only a thorough study of the entire family can determine whether the absence of pereiopodal epipods in *Pomagnathus* and their presence in the superficially similar species of *Alpheus* is of sufficient importance to justify the retention of the genus.

DISTRIBUTION: Known otherwise only from Arena Bank, Baja California.

Synalpheus biunguiculatus (Stimpson)

Alpheus biunguiculatus Stimpson, 1860, p. 31.
Synalpheus biunguiculatus Banner, 1953, p. 32, fig. 9.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 2 ovigerous females.—Northeast transect, 36 feet; August 27, 1958; Chess and Hambly; 1 ovigerous female.—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 1 specimen.—From coral in 20–40 feet; August 1958; Allison and Limbaugh; 1 ovigerous female.—Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 1 specimen.

MEASUREMENTS: Carapace lengths to base of rostrum, 3.1-4.7 mm.; of ovigerous females, 3.3–4.7 mm.

REMARKS: The two specimens without eggs are probably males, as indicated by the form of the abdominal pleura and pleopods; each has a carapace length of 3.1 mm. The specimen with a carapace length of 4.7 mm. is referred to this species with some doubt, for it lacks all of the pereiopods; the largest specimen that is identified with certainty has a carapace length of only 3.9 mm.

There seems to be considerable variation in this species as regards the breadth of the rostrum, the proportions of the segments of the antennular peduncle, the length of the stylocerite, the length of the

terminal spine on the antennal scale, the divergence of the ventral spine on the dactyls of the last three pereiopods, and the disposition of the dorsal spines on the telson. In all of the specimens examined, including the neotype, both pairs of dorsal spines are situated on the posterior half of the telson, rather than as indicated in Banner's description and figure. The neotype also has the rostrum considerably narrower and the ventral spines of the ambulatory dactyls more divergent than in the specimen figured by Banner.

DISTRIBUTION: Known previously only from the Hawaiian Islands.

Synalpheus nobilii Coutière

Synalpheus nobilii Coutière, 1909, p. 40, fig. 22.—Schmitt, 1939, pp. 12, 24.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 28 specimens (8 ovigerous).—Poison; October 20, 1956; W. Baldwin; 18 specimens (mostly juveniles, 1 ovigerous).—East side, coral reef; August 9, 1958; Sta. W58–283; Reese, Baldwin, and Wintersteen; 1 specimen.—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 13 specimens (3 ovigerous).—Northeast transect, 36 feet; August 27, 1958; Chess and Hambly; 2 specimens (1 ovigerous).—Northeast transect, 78 feet; August 27, 1958; C. Limbaugh; 1 juvenile.—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 5 specimens.—East side, reef flat, margin or ridge, 0–2 feet; September 14, 1958; Limbaugh and Chess; 2 specimens.

MEASUREMENTS: Carapace lengths to base of rostrum, 2.0–7.0 mm.; of ovigerous females, 3.7–7.0 mm.

REMARKS: Specimens that appear to be males, from the form of the abdominal pleura and pleopods, have a maximum carapace length of 5.8 mm.; the three specimens larger than this are all ovigerous. This species bears a resemblance to the very variable *S. paraneomeris* Coutière, which is found throughout the Indo-Pacific region and is common in the Hawaiian Islands, but *S. nobilii* can be recognized readily by the prominent dorsal spine on the basal antennal segment (basicerite).

DISTRIBUTION: Known otherwise only from Ecuador and the Galapagos Islands.

Synalpheus charon (Heller)

Alpheus charon Heller, 1861, p. 27.
Synalpheus charon Banner, 1953, p. 37, fig. 11.

MATERIAL: Northwest end, reef; August 14, 1958; Sta. W58–288; Reese, Baldwin, and Wintersteen; 1 ovigerous female.—Northeast transect, 36 feet: August 27, 1958; Chess and Hambly; 3 specimens (1 ovigerous).—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 3 specimens.—Northeast corner, 45 feet; August

30, 1958; Limbaugh, Chess, and Hambly; 3 specimens (2 ovigerous).—Coral at 20 to 40 feet; August 1958; Allison and Limbaugh; 2 specimens (1 ovigerous).—East side, reef flat, margin or ridge, 0–2 feet; September 14, 1958; Limbaugh and Chess; 2 specimens.—Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 1 specimen.

MEASUREMENTS: Carapace lengths to base of rostrum, 1.9–6.0 mm.; of ovigerous females, 5.3–6.0 mm.

REMARKS: Specimens that appear to be males, from the form of the abdominal pleura and pleopods, have a maximum carapace length of 5.2 mm., shorter than that of the smallest ovigerous female; all larger specimens are ovigerous.

DISTRIBUTION: Red Sea to Baja California.

Family Hippolytidae

Lysmata trisetacea (Heller)

Hippolyte trisetacea Heller, 1861, p. 29.
Hippolysmata paucidens Rathbun, 1906, p. 913, pl. 24, fig. 4.
Lysmata paucidens Schmitt, 1939, p. 12.
Lysmata trisetacea Holthuis, 1947, pp. 19, 65.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 28 males, 5 females (3 ovigerous).—East side, coral reef; August 9, 1958; Sta. W58–283; Reese, Baldwin, and Wintersteen; 1 male, 1 ovigerous female.—South shore, coral reef; August 11, 1958; Sta. W58–285; Reese, Limbaugh, Baldwin, and Wintersteen; 2 males.—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 5 males, 14 females (12 ovigerous).—South shore, coral reef; August 19, 1958; Sta. W58–295; Reese, Baldwin, and Limbaugh; 3 males, 2 ovigerous females.

MEASUREMENTS: Carapace lengths of males, 2.0–4.5 mm.; of females without eggs, 2.0–4.7 mm.; of ovigerous females, 3.5–6.2 mm. Total length of largest male, 17.5 mm.; of largest female, 22 mm.

REMARKS: Males with carapace lengths of 2.0 and 2.1 mm. usually have the appendix maxculina on the second pleopods ranging in size from a scarcely visible bud to slightly longer than the appendix interna; in mature males, it is nearly twice as long. There is, however, a single male with a carapace length of 2.0 mm. in which the appendix masculina is nearly fully developed. Apparently the appendix masculina normally reaches its maximum size at a carapace length of 2.2 mm., for all but one male of that size and all larger ones have the appendix masculina fully developed.

It is noteworthy that 34 of the 36 specimens with carapaces less than 3.5 mm. long are males. The two possible exceptions have carapaces only 2.0 mm. long and they might be juvenile males, in which the appendix masculina has not yet appeared, rather than

females. Conversely, only four of the males in the collection are larger than the smallest certain female. But for these four males, whose carapaces measure 3.7, 4.0, 4.3, and 4.5 mm., the species would be considered protandrous. Of the 20 certain females, all but two are ovigerous; those two have carapace lengths of 4.0 and 4.7 mm.

The rostral formula of these specimens varies as follows (the numbers in parentheses indicate the number of specimens with each arrangement): $\frac{2+2}{2}$ (24); $\frac{2+2}{1}$ (11); $\frac{1+2}{1}$ (8); $\frac{1+2}{2}$ (8); $\frac{2+3}{2}$ (2); $\frac{0+2}{1}$ (1); $\frac{1+3}{1}$ (1); $\frac{2+2}{0}$ (1). The tooth in front of the hindmost one in the dorsal series and one of the ventral teeth are apparently the last to appear. All but two of the 22 specimens with carapace lengths of 2.6 mm. or less have the second dorsal rostral tooth small or absent. Of the 35 larger specimens with intact rostra, only seven have the second dorsal tooth reduced or missing. These seven specimens range in carapace length from 2.7 to 4.5 mm.; only one of the four largest is a male, so the reduction of the second tooth is probably not a sexual character. All but three of the 22 specimens with less than two ventral rostral teeth are less than 3.0 mm. in carapace length, and only nine of the 28 specimens of this size have more than one ventral tooth.

The branches of the upper antennular flagellum are fused to a variable extent in large specimens, but the length of the fused portion varies rather constantly with size in young individuals. In specimens with carapace lengths of 2.0 and 2.1 mm., the fused portion is longer than the free portion of the shorter branch; in one apparently aberrant specimen with a carapace length of 2.0 mm., the fused part is ten times as long as the free part but usually it is not nearly twice as long. At carapace lengths of 2.2 and 2.3 mm., the fused and free parts are approximately equal. From 2.4 to 3.3 mm. the fused part is always shorter than the free part but distinctly more than half as long. In larger specimens the fused portion varies from slightly more than a half to barely a third as long as the free part.

The number of segments in the carpus of the second pereiopods is reasonably constant, and the variation that was observed is not correlated with size or sex. The number of carpal segments may be arranged as follows, in order of decreasing occurrence: 21, 20, 22, 23, 24, 19. Of the 105 second pereiopods represented, no less than 100 had the carpus composed of 20, 21, or 22 segments. One specimen had 19 segments on one side only, two specimens had 23 segments on one side only, and two specimens had 24 segments on one side only. Fewer than 20, and more than 22, carpal segments may therefore be

considered unusual and perhaps abnormal in Clipperton material.

After examining the syntypes of *Hippolysmata paucidens* Rathbun from the Hawaiian Islands, L. B. Holthuis (personal communication) concluded that that species should be synonymized with *Lysmata trisetacea*, as he had suggested in 1947.

Comparison of the three males, eight ovigerous females, and one cephalothorax from the Hawaiian Islands with the Clipperton specimens disclosed minor, but possibly significant, differences. In three of the Hawaiian specimens, the posterior ventral rostral tooth is behind or opposite the anterior dorsal tooth; in all but two of the Clipperton specimens both ventral teeth, when present, are well in advance of the anterior dorsal tooth. All of the Hawaiian specimens, in which the carapace measures from 2.6 to 3.6 mm. in males and from 4.0 to 4.8 mm. in females, have the fused part of the upper antennular flagellum not much shorter than the free portion of the shorter branch; in Clipperton specimens of comparable size, the fused portion is at most little more than half as long as the free portion and it may be no more than a third as long. The number of segments in the carpus of the second pereiopods varies from 21 to 25, and averages more than 23 in the Hawaiian material, as opposed to a range of 19 to 24 and an average of less than 21 in the Clipperton specimens. It is very possible that the Clipperton form is at least subspecifically distinct but, in view of the variation recorded in the literature for material from the western Indo-Pacific, it is best to postpone taxonomic recognition of these differences until more extensive populations from different parts of the range of *L. trisetacea* can be compared.

Although *Lysmata galapagensis* Schmitt is very similar to *L. trisetacea*, re-examination of the type series of that species has shown that the two are distinct species, as noted by Schmitt in 1939.

Distribution: Red Sea to the Hawaiian Islands and Clipperton Island.

Family Processidae

Processa hawaiensis (Dana)

Nika hawaiensis Dana, 1852, p. 538; 1855, pl. 33, fig. 7.
Processa paucirostris Edmondson, 1930, p. 3, fig. 1; 1946, p. 248, fig. 148b.

Material: Poison; October 20, 1956; W. Baldwin; 4 males, 2 females (1 ovigerous).—East end, coral reef; August 15, 1958; Sta. W58-289; Reese, Baldwin, and Wintersteen; 4 ovigerous females.

Measurements: Carapace lengths of males, 1.7–2.3 mm.; of female without eggs, 1.7 mm.; of ovigerous females, 3.1–4.7 mm.

Remarks: *Processa paucirostris* was proposed by Edmondson (1930) for a specimen that corresponded with Dana's description of *Nika hawaiensis* in most particulars. The only important distinguishing

character was the number of segments in the carpus of the second pereiopod: 18 in *P. paucirostris*, 11 in *P. hawaiensis*. Edmondson's count was based on the right second pereiopod (he stated in 1946 that the one on the left side was not observed); Dana did not indicate which of the second pereiopods was examined. In the series of Clipperton specimens, there are from 17 to 19 segments (very difficult to determine in the smallest specimens) in the carpus of the right second pereiopod, and 11 to 13 (usually 11) in the carpus of the left member of the pair. Inasmuch as *P. hawaiensis* and *P. paucirostris* agree in most other characters, including an unusual rostrum for the genus, it seems logical to assume that they are synonymous. In all of the Clipperton specimens, the right first pereiopod is chelate, the left simple.

DISTRIBUTION: Known previously only from the Hawaiian Islands.

Family Palinuridae

Panulirus penicillatus (Olivier)

Astacus penicillatus Olivier, 1791, p. 343.
Panulirus penicillatus Boone, 1935, p. 67, text-fig. 2, pl. 17.—Holthuis, 1946, p. 125.

MATERIAL: Coral reef, intertidal; August 1958; E. S. Reese; 1 male.—Northeast side, dead on beach; September 14, 1958; C. Limbaugh; 1 male.—West side, on beach; September 21, 1958; C. Limbaugh; 1 cast shell of male.

MEASUREMENTS: Carapace lengths in dorsal midline, 25.0–48.5 mm.

DISTRIBUTION: Red Sea and South Africa to Hawaiian, Tuamotu, Socorro, Cocos, and Galapagos Islands.

Family Callianassidae: Subfamily Callianassinae

Callianassa (Callichirus) placida De Man

Callianassa placida De Man, 1905, p. 612.
Glypturus grandimanus Balss, 1924, p. 179, figs. 3, 4. Not *Callianassa grandimana* Gibbes, 1850.
Callianassa (Callichirus) placida De Man, 1928, p. 171, pl. 18, figs. 29–29b, pl. 19, figs. 29c–29e.
Callianassa hartmeyeri Schmitt, 1935, p. 3.—Hult, 1938, p. 7, figs. 1–4, pl. 1.—Schmitt, 1939, p. 15.
Callianassa (Callichirus) oahuensis Edmondson, 1944, p. 56, fig. 10.

MATERIAL: Northwest shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 1 male, 1 ovigerous female.—Northwest corner, reef, coral cobble beach; August 14, 1958; Sta. W58–288; Reese, Baldwin, and Wintersteen; 1 female.—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 1 ovigerous female.—South shore, coral reef; August 19, 1958; Sta. W58–295; Reese, Baldwin, and Limbaugh; 1 ovigerous female.—Northeast

side, reef flat, 0–1 foot at low tide; collected with "Endrin" insecticide; September 13, 1958; Limbaugh, Chess, and Hambly; 1 female.

MEASUREMENTS: Carapace length of male to base of rostrum, 8.9 mm.; of females without eggs, 5.1–9.0 mm.; of ovigerous females, 9.5–12.5 mm. Total length of largest specimen, about 55 mm.

REMARKS: Fully formed larvae are visible in the eggs carried by the largest specimen, which was taken on August 19, 1958.

The two females without eggs agree very well with De Man's description and figures except that there are two teeth, one above the other, on the inner, proximal part of the dorsal surface of the outer uropods, as noted by Edmondson in *C. oahuensis*. De Man mentions only one tooth in this position, but the lower one is concealed and easily overlooked in small specimens, and De Man's figure suggests two teeth. In the smallest female in the present collection—which is a little smaller than De Man's largest, figured specimen, also a female—and in the male—which is the next to the smallest specimen in the Clipperton series—the rostrum slopes downward slightly as in the *Siboga* specimens; in the next larger specimen—a female with a carapace length of 9.0 mm.—the rostrum is horizontal with a bulge near the base; in the three ovigerous females, it is directed slightly upward, approaching the condition in *C. oahuensis*. In the two smallest females, the inner margin of the outer uropod is sinuous basally, faintly convex distally, and it curves gradually into the true distal margin without any indication of an angle, much as in De Man's figure; in the male and the ovigerous female with a carapace length of 10.8 mm., the inner margin of that segment is markedly concave, as in Edmondson's figure, but there is no angle at the juncture with the distal margin; in the smallest and largest ovigerous females, the inner margin is also concave, but there is a broadly obtuse angle at the juncture with the distal margin. The forms of the rostrum and of the uropods, the characters by which Edmondson separated *C. oahuensis* from *C. placida*, apparently vary considerably, possibly with growth; if so *C. oahuensis* is a synonym of De Man's species.

C. hartmeyeri is relegated to synonymy with less assurance because both Balss and Hult failed to mention or figure the inner, distal prolongation of the eyestalk beyond the cornea. This lobe is very apparent in most of the Clipperton specimens, but it is much reduced in the male. Inasmuch as *C. hartmeyeri* seems to agree with *C. placida* in all other particulars, it may be reasonable to assume that the eyestalk lobes were overlooked in the specimens from the Galapagos Islands and Jamaica.

There is no doubt that *C. grandimana* is a distinct species. As Schmitt pointed out, the "second segment" of the major cheliped described by Gibbes was certainly the ischium, as indicated by his

"correction" of Say's description of the cheliped of *C. major*: "what he calls first joint of the hand is really the carpus; his carpus [merus] is the third joint or segment, and so on." Gibbes's reference to "distant granules" on the lower edge of the ischium could hardly be applied to the long, prominent spines on that segment in Balss's specimen. Hult's understandable difficulty in reconciling the characters cited by Schmitt (1935) with Balss's description and figure was caused by the inadvertent transposition of the names in the last couplet of the key; it will be seen that the characters given in the first half of that couplet for *C. longiventris* agree with those given by Balss.

De Man noted the similarity between *C. placida* and *C. coutierei* Nobili, but the different form of the eyes is probably sufficient to distinguish the latter species.

The telson shows considerable variation in the six Clipperton specimens. The non-ovigerous female with a carapace length of 9.0 mm. has the posterior margin very like that in the specimen figured by De Man, sinuously transverse with the median lobe extending slightly beyond the posterolateral lobes. In all of the other specimens, the posterolateral lobes distinctly surpass the median lobe, so that the margin is sinuously concave; in the male and the largest ovigerous female, the median lobe is obsolescent, so that the margin is deeply and almost regularly concave.

Distribution: Otherwise known from the East Indies (Savu and Obi Major), Hawaiian Islands, Galapagos Islands (?), and West Indies (Jamaica) (?).

Family Porcellanidae

Pachycheles biocellatus (Lockington)

Petrolisthes (*Pisosoma*) *biocellatus* Lockington, 1878, p. 403.
Pisosoma aphrodita Boone, 1932, p. 53, fig. 17.
Pachycheles biocellatus Glassell, 1937a, p. 84.—Schmitt, 1939, p. 16.—Haig, 1960, p. 144, pl. 32, fig. 1.

Material: Northwest shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 11 males, 8 ovigerous females.—Northeast transect, 36 feet; August 27, 1958; Chess and Hambly; 1 ovigerous female.—Northeast transect, 78 feet; August 27, 1958; C. Limbaugh; 1 male, 1 ovigerous female.—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 7 males, 4 females (3 ovigerous).—Northeast corner; August 29, 1958; C. Limbaugh; 1 ovigerous female.—Northeast corner, 45 feet; August 30, 1958; Limbaugh, Chess, and Hambly; 2 ovigerous females.—Coral reef, intertidal; August 1958; E. S. Reese; 2 males.—Coral at 20 to 40 feet; August 1958; Allison and Limbaugh; 1 ovigerous female.—East side, reef flat, margin or ridge, 0–2 feet; September 14, 1958; Limbaugh and Chess; 2 males, 1 ovigerous female.

MEASUREMENTS: Carapaces of males 3.2 mm. long and 3.2 mm. wide to 7.0 mm. long and 7.2 mm. wide, of female without eggs 3.3 mm. long and 3.3 mm. wide, of ovigerous females 3.5 mm. long and 3.6 mm. wide to 6.8 mm. long and 7.3 mm. wide.

REMARKS: It will be noted that all 18 females with carapace lengths and widths greater than 3.3 mm. were ovigerous, whether collected in July, August, or September. All but one of the specimens collected in 1958 still retain enough of the original color to show the characteristic white spot on each anterolateral angle of the carapace; the exception apparently had the carapace uniformly red everywhere.

DISTRIBUTION: Otherwise known from the Gulf of California to Ecuador and Isabel, Tres Marias, Revilla Gigedo, and Galapagos Islands.

Petrolisthes haigae, new species

FIGURE 1

Petrolisthes galathinus Boone, 1932, p. 45 (not fig. 13).—? Hult, 1938, p. 10. Not *Porcellana galathina* Bosc, 1801.

Petrolisthes marginatus Schmitt, 1939, p. 16—Hertlein and Emerson, 1957, p. 5.—Haig, 1960, p. 47 (part), pl. 20, fig. 1. Not *P. marginatus* Stimpson, 1859.

MATERIAL: Northeast shore, rocks south of landing place; July 21, 1938; Sta. 9; W. L. Schmitt; 6 males, 12 females (10 ovigerous).—October 1956; C. Limbaugh; 6 males, 2 females.—Northwest end, reef; August 14, 1958; Sta. W58–288; Reese, Baldwin, and Wintersteen; 2 females (1 ovigerous).—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 3 males, 1 ovigerous female [1 male is holotype, USNM 107840].—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 5 males, 5 females (1 ovigerous).—Northeast side, low intertidal to 6 feet; September 4, 1958; Limbaugh, Chess and Hambly; 2 males.—East side, reef flat, margin or ridge, 0–2 feet; September 14, 1958; Limbaugh and Chess; 1 male.—Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 1 female.

DESCRIPTION: Carapace longer than wide, except in largest specimens. Surface pubescent and without rugae, except for usual ridge across anterior gastric region and inconspicuous lines on lateral branchial regions. A single, sharp epibranchial spine on each side. No supraocular spines. Front sinuously triangular with crenulate margin. Lateral wall of carapace entire and provided with three or four strong, longitudinal carinae.

Chelipeds slightly unequal, similar. Merus with inner lobe triangular; a single, sharp spine on distal dorsal margin and a second,

FIGURE 1.—*Petrolisthes haigae*, new species, male holotype, showing color pattern in preserved specimen: *a*, Carapace and chelipeds, × 5.4; *b*, right first walking leg, × 3.8; *c*, right third maxilliped, × 3.8; *d*, right antennule in ventral view, × 10.8.

smaller one proximad to it on outer dorsal surface; a single, sharp spine on distal ventral margin. Carpus with row of prominent, scale-like rugae near dorsal midline; inner margin with four or five, rarely six, broad, denticulate teeth, the proximal two or three spine-tipped; outer margin with tooth-like rugae over entire length, and armed, in addition to terminal pair of spines, with none to five, usually three, sharp spines. Chelae densely pubescent, especially on outer part, with prominent ridge running proximad from gape of fingers and separating horizontal inner portion of hand from slanting outer

portion; outer margin crenulate but unarmed in specimens more than 6.0 mm. long, spinose in specimens less than 3.5 mm. long. Fingers meeting throughout and pubescent on inner, lower margins.

Merus of first walking leg armed on dorsal margin with five or six, rarely seven, spines and fringe of plumose hairs and with one strong spine at distoventral angle below acute or spinose lobe; no spine at upper distal angle. Merus of second leg with five or six dorsal spines and one distoventral spine below rounded lobe which may occasionally bear a second spine at its lower angle; upper distal angle acute but not dentiform. Merus of third leg with four or five, rarely two or three, dorsal spines and unarmed at rounded distoventral angle; upper distal angle dentiform but not spinose.

Telson composed of seven plates.

Measurements: Carapace of male holotype, 7.9 mm. long and 7.4 mm. wide. Carapace lengths of Clipperton Island males, 3.2–8.0 mm.; of females without eggs, 2.0–5.2 mm.; of ovigerous females, 5.0–9.8 mm.

Color: Specimens preserved in ethyl alcohol retain much of original color pattern, even after 20 years. Dorsal surface of carapace and chelipeds spotted with red, sometimes to such a degree as to form a checkerboard pattern on carapace. Ventrally, sternum and appendages everywhere deep crimson.

Remarks: Most previous authors have believed this species to be identical with the West Indian *P. marginatus* Stimpson. It is distinguished from that species, however, by the much less transverse lateral lobes of the front and by the presence of only one, rather than two, epibranchial spines on each side of the carapace.

The species is named for Miss Janet Haig who has added so much to our knowledge of the porcellanid crabs, especially those from the eastern Pacific, and who has provided valuable information for the present study from material in the collections of the Allan Hancock Foundation.

Distribution: In addition to the Clipperton collections, material of the typical form of *P. haigae* has been examined from the Tres Marias, Clarion, and Galapagos Islands. Miss Haig (in correspondence) states that there are also typical specimens in the Hancock collections from the Gulf of California and Revilla Gigedo Island. In general, specimens of the analogous form found on the mainland from Mexico to Colombia are more spinose than the typical form, especially on the supraorbital margin and the outer margins of the carpus and hand of the chelipeds. It is very possible that further study will prove the mainland form to be specifically distinct.

Petrolisthes glasselli Haig

Petrolisthes glasselli Haig, 1957, p. 33, pl. 8; 1960, p. 39, pl. 20, fig. 2.

MATERIAL: Northeast side, 50–60 feet; September 20, 1958; C. Limbaugh; 3 males, 3 ovigerous females.

MEASUREMENTS: Carapace lengths of males, 4.6–6.0 mm.; of ovigerous females, 5.0–7.1 mm.

REMARKS: Comparison of the present series with the holotype and other specimens of *P. glasselli* from Colombia reveals no obvious morphological differences, but the color patterns are strikingly distinct. Colombian specimens, in which the color pattern persists, have transverse bands of deep purplish red, corresponding with the striations, on the dorsal surfaces of the carapace and chelipeds, as described by Miss Haig. In the Clipperton material, these bands are more or less regularly interrupted so that the crabs appear grossly spotted from above. Whether this color difference has any taxonomic significance can only be determined by the examination of fresh material from other parts of the range of the species.

DISTRIBUTION: Otherwise known from Gulf of California to Colombia and Isabel, Tres Marias, Revilla Gigedo, and Galapagos Islands.

Family Paguridae: Subfamily Pagurinae

?*Pagurus lepidus* (Bouvier)

FIGURE 2

Eupagurus lepidus Bouvier, 1898, p. 381.
Pagurus lepidus Glassell, 1937b, p. 256.

MATERIAL: Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 1 male, 2 ovigerous females.

MEASUREMENTS: Length of anterior part of carapace, from tip of rostrum to cervical groove: male, 1.8 mm.; ovigerous females, 1.4–2.0 mm.

REMARKS: These specimens agree in most particulars with a lot of two males, one female, and five juveniles in the collections of the U.S. National Museum from the Gulf of California at Puerto Penasco, Sonora, Mexico. The only striking difference is in the form of the ocular scales; in all of the Mexican specimens, the scales are armed on the median margins with four to six prominent spines, as stated by Bouvier, whereas those spines are replaced by setae in the Clipperton specimens. It is very possible that this difference will prove to be of specific or subspecific importance, but it seems best to avoid proposing a new name until more specimens from various localities can be studied.

DISTRIBUTION: Previously recorded only from the Gulf of California.

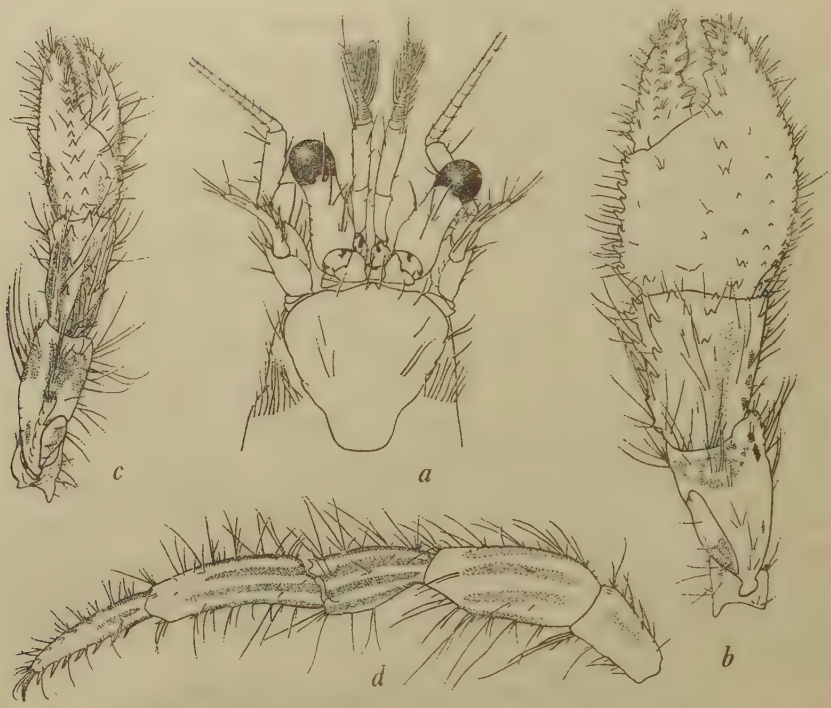

FIGURE 2.—? *Pagurus lepidus* (Bouvier), male, showing color pattern in preserved specimen, × 12.4: *a*, Anterior part of carapace in dorsal view; *b*, right cheliped; *c*, left cheliped; *d*, left third pereiopod.

Subfamily Diogeninae

Calcinus explorator Boone

FIGURES 3–4

Calcinus obscurus Schmitt, 1924, p. 170; 1939, pp. 11, 25, 26. Not *C. obscurus* Stimpson, 1859.
Calcinus explorator Boone, 1932, p. 21, fig. 6.

MATERIAL: Rocky intertidal areas; August 7–26, 1958; E. S. Reese; 85 males, 98 females (56 ovigerous).—Northeast side, reef flat, 0–1 foot at low tide; collected with "Endrin" insecticide; September 13, 1958; Limbaugh, Chess, and Hambly; 1 male.

MEASUREMENTS: Length of anterior part of carapace, from tip of rostrum to cervical groove: males, 1.7–6.8 mm.; females without eggs, 1.6–3.5 mm.; ovigerous females, 2.3–5.0 mm. The length of the entire carapace in the midline is difficult to measure accurately, because of the membranous posterior part, but it is slightly less than twice (1.8–1.9) as long as the anterior portion.

FIGURE 3.—*Calcinus explorator* Boone, male with anterior carapace length of 5.0 mm,. showing color pattern in preserved specimen, × 6.5: *a*, Anterior part of carapace in dorsal view; *b*, left cheliped; *c*, right cheliped; *d*, left third pereiopod.

COLOR: The following description is based on notes made in the field by E. S. Reese. Entire carapace dark gray to greenish. Abdomen light to dark brown to gray. Eye scales white. Eyestalks black with narrow white band immediately proximad to cornea. Antennae, including scales, orange. Chelipeds black; fingers with white cutting edges and orange tips. Walking legs black, with proximal and distal thirds of dactyls orange. Mouth parts greenish, with deep red setae on maxillipeds. The darker colors change to orange in some preservatives, but the pattern persists for several years in most specimens.

REMARKS: Although constant morphological differences between this species and *C. obscurus* Stimpson from Central America could not be found, fresh material of the two forms can always be distinguished by the extent of the white band on the eyestalks and of the orange bands on the dactyls of the walking legs. In *C. obscurus*, the band on the eyestalk is much broader and the proximal band on the dactyls of the walking legs is very narrow, often incomplete cr even absent,

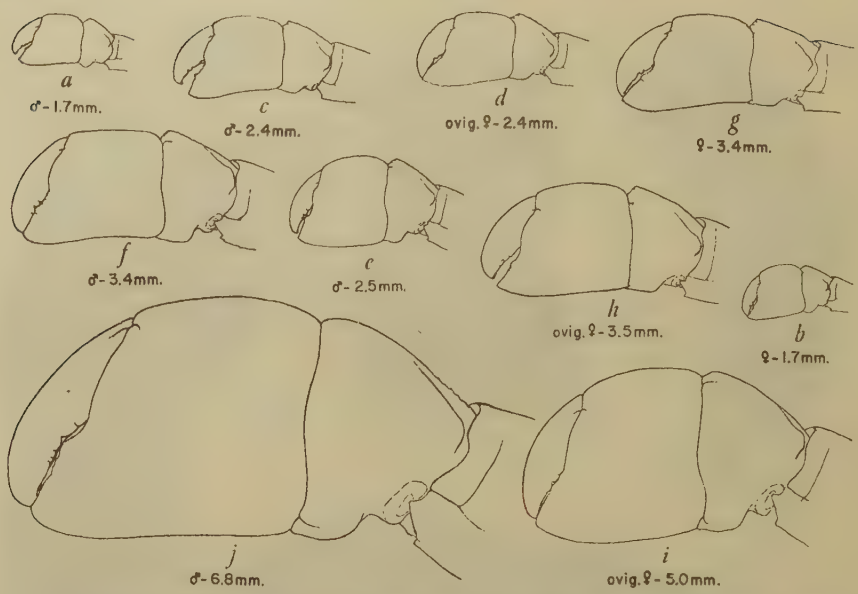

FIGURE 4.—*Calcinus explorator* Boone, left chelae, × 4.8, of specimens having anterior carapace lengths as indicated.

as indicated by Holthuis (1954, p. 22, figs. 5 and 6). Unfaded material of *C. obscurus* in the U.S. National Museum corresponds very well with Holthuis's description and figures. Likewise, comparison of Clipperton specimens with Galapagos material in which the color pattern is still visible verifies the identity of those two forms. Although the morphological characters cited by Boone (1932) to distinguish *C. explorator* from *C. obscurus* are too variable to be valid, the broad orange bands on the dactyls of the walking legs in Galapagos specimens were noted by both Schmitt (1927) and Boone. *C. explorator* may eventually prove to be a subspecies of *C. obscurus*, but the absence of intermediate color forms in the material at hand suggests that the two are specifically distinct. Color patterns seem to be more constant and reliable than morphological characters in the genus *Calcinus*.

For differences between *C. explorator* and *C. californiensis*, see the remarks under the latter species.

DISTRIBUTION: Previously recorded from the Galapagos and Cocos Islands, but the latter locality needs verification. Specimens from Socorro Island, Mexico, in the U.S. National Museum also belong to this species, but material from Cocos and Clarion Islands has lost all traces of the color pattern and cannot be positively identified.

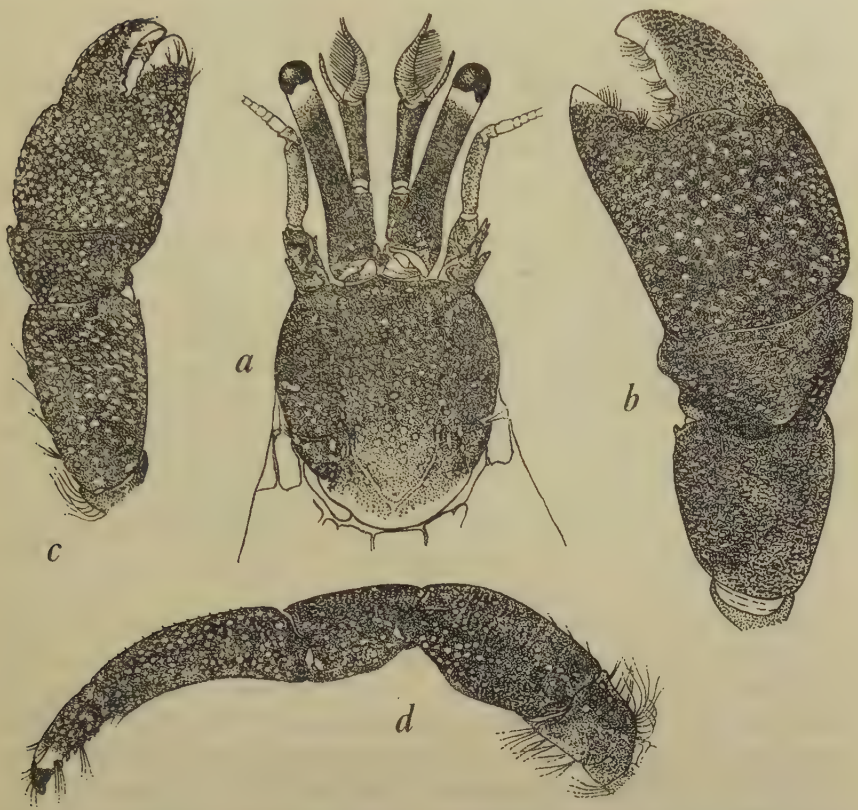

FIGURE 5.—? *Calcinus californiensis* Bouvier, male with anterior carapace length of 4.3 mm. showing color pattern in preserved specimen, × 7.7: *a*, anterior part of carapace in dorsal view; *b*, left cheliped; *c*, right cheliped; *d*, left third pereiopod.

?*Calcinus californiensis* Bouvier

FIGURES 5–6

Calcinus californiensis Bouvier, 1898, p. 380.—Glassell, 1937b, p. 252.—Steinbeck and Ricketts, 1941, p. 453.

MATERIAL: Northwest end, reef; August 14, 1958; Reese, Baldwin, and Wintersteen; 1 male, 1 ovigerous female (eggs hatching).—Rocky intertidal areas; August 7–26, 1958; E. S. Reese; 39 males, 32 females (2 ovigerous).—Northeast side, 45 feet; August 28, 1958; Limbaugh, Chess, and Hambly; 4 males, 2 females (1 ovigerous).—Northeast corner, 45 feet; August 30, 1958; Limbaugh, Hambly, and Chess; 2 males, 1 ovigerous female.—Northeast side, low intertidal to 6 feet; September 4, 1958; Chess, Limbaugh, and Hambly; 1 female, 2 juveniles.—Northeast side, reef flat, 0–1 foot at low tide; collected with "Endrin" insecticide; September 13, 1958; Limbaugh, Chess, and

Hambly; 1 male.—East side, reef flat, 0–2 feet; September 14, 1958; Limbaugh and Chess; 1 ovigerous female.

MEASUREMENTS: Length of anterior part of carapace, from tip of rostrum to cervical groove: males, 1.3–4.2 mm.; females without eggs, 1.4–3.0 mm.; ovigerous females 2.0–4.7 mm. The length of the entire carapace in the midline is slightly less than twice as long as the anterior portion.

COLOR: The following description is based on notes made in the field by E. S. Reese. Carapace anterior to cervical groove orange to red, except for gastric area which is dark gray or black; part posterior to cervical groove, pink to dark orange. Abdomen tan. Eye scales white. Eyestalks black with broad white band immediately proximad to cornea. Antennae, including scales, red. Chelipeds black with margins of hand red; fingers with yellowish to white cutting edges and orange to red tips. Walking legs red, dactyls orange. The darker colors change to orange in some preservatives, but the red color remains unchanged; preserved specimens of *C. californiensis* may therefore appear darker than those of *C. explorator*. The pattern persists for several years in most specimens.

REMARKS: No unfaded specimens of *C. californiensis* from the Mexican mainland have been available for comparison; the Clipperton specimens are therefore assigned to that species with reservations. Bouvier's description of the color, presumably based on alcoholic specimens, agrees very well with that observed in the Clipperton series. Glassell's mention of the unbanded dactyls of the walking legs and, even more significant, the reference by Steinbeck and Ricketts to the red coloration of the species in life indicate that *C. californiensis* is distinct from *C. obscurus* Stimpson.

Clipperton specimens of *C. explorator* and *C. californiensis* can be readily distinguished in life by the color of the walking legs: black in the former and red in the latter. Unfaded preserved material may be separated only slightly less easily by the banded ambulatory dactyls and narrow eyestalk band of *C. explorator* in contrast with the unbanded dactyls and broad eyestalk band of the latter. Faded specimens require careful examination and comparison, because the morphological characters are subject to considerable variation.

In spite of the range of form exhibited by the major chela (figures 4 and 6), that appendage probably affords the most useful means of distinguishing the two species when the color pattern has disappeared. The fixed finger in *C. explorator* is characteristically short, broad, and poorly defined because the distal margin of the palm is oblique and almost continuous with the upper margin of the fixed finger. In *C. californiensis*, the distal margin of the palm is more nearly transverse, and the angle it makes with the fixed finger is

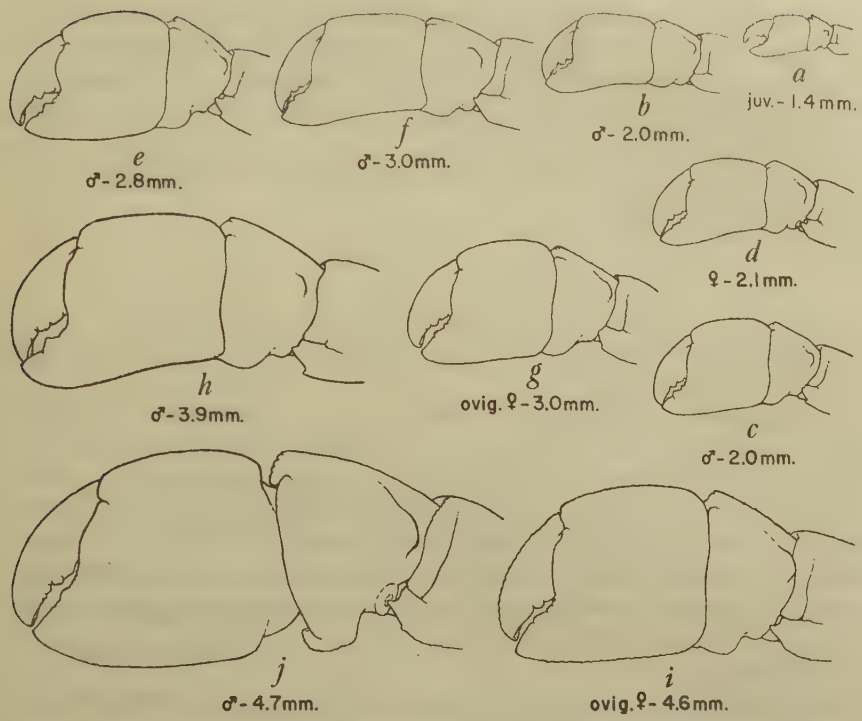

FIGURE 6.—? *Calcinus californiensis* Bouvier, left chelae, × 6.0, of specimens having anterior carapace lengths as indicated.

always apparent even though broadly obtuse. In those specimens of each species in which that angle is nearly identical (e.g., figures 4g and 6j), it will be noticed that the chela of *C. explorator* is of the elongate form and that of *C. californiensis* is short and broad with convex margins. If, therefore, specimens of each species having similarly shaped chelae are compared, there is little difficulty in separating them.

Another character that is often useful in distinguishing *C. californiensis* is provided by the propodus of the left second walking leg (third pereiopod). In *C. explorator*, the outer surface of that segment is rather evenly convex and forms a blunt angle with the comparatively broad upper surface. In most specimens of *C. californiensis*, the upper part of the outer surface is flattened, or even concave, and rugose, and the upper surface is narrower than in *C. exploraton;* the rugose sulcus on the outer surface approaches, but never equals, the condition found in *C. tibicen* (Herbst) of the western Atlantic.

There is also a tendency for the eye scales of *C. californiensis* to bear more teeth than those of *C. explorator*, but that character is of

little practical importance in recognizing the species. In the Clipperton series of *C. explorator*, 8 eye scales lack teeth entirely, 350 bear one tooth, and only 8 have two distinct teeth. In *C. californiensis*, none of the scales are unarmed, 121 have one tooth, 50 have two, and 2 have three.

DISTRIBUTION: Recorded previously only from the Gulf of California and Acapulco, Mexico.

Family Hippidae

Hippa pacifica (Dana)

Remipes pacificus Dana, 1852, p. 407; 1855, pl. 25, fig. 7.—De Man, 1896, p. 476; 1898, pl. 33, fig. 53.

MATERIAL: East side, coral reef; August 9, 1958; Sta. W58–283; Reese, Baldwin, and Wintersteen; 3 males, 1 juvenile.—East end, coral reef; August 15, 1958; Sta. W58–289; Reese, Baldwin, and Wintersteen; 2 juveniles.—North side, sand beach; August 15, 1958; E. S. Reese; 8 males, 14 females (10 ovigerous).—South shore, coral reef; August 19, 1958; Sta. W58–295; Reese, Baldwin, and Limbaugh; 1 male, 1 female.—Northeast side, sand near dead shark awash at high tide; September 11, 1958; C. Limbaugh; 24 males, 54 females (42 ovigerous).

MEASUREMENTS: Carapace length in midline: males, 5.5–14.2 mm.; females without eggs, 7.7–18.7 mm.; ovigerous females, 10.8–18.2 mm.

REMARKS: Although the front is usually evenly concave between the submedian lobes, 29 of the 108 specimens from Clipperton Island have a suggestion of a median lobe, and in a few of them it is quite distinct. The number of tufts of setae above each lateral margin of the carapace varies as follows (the number in parentheses indicating the number of examples): 29(1), 30(1), 31(7), 32(9), 33(40), 34(40), 35(42), 36(33), 37(23), 38(10), 39(8).

DISTRIBUTION: East Indies to Gulf of California.

Distribution of Non-Brachyuran Decapods

As shown in figure 7, 14 of the 24 non-brachyuran decapods now known from Clipperton Island have been recorded from some part of the Indo-Pacific region to the west. Of those 14, only 6 have been reported from the other islands in the extreme eastern Pacific or from the American mainland. According to present knowledge, therefore, Clipperton represents the easternmost limit, in the Pacific, of no less than 8 species. The remaining 10 of the 24 species seem to be restricted to the eastern Pacific; 7 of them have been found on the American mainland. None of the 24 Clipperton species are

endemic, and none are thus far known to be pantropical, although 5 of them have been recorded from the Atlantic. Present incomplete information indicates that all 5 of the species that may occur in the Atlantic are also known from Hawaii or the western Pacific, and only 1 of them has been found in the eastern Pacific; in other words,

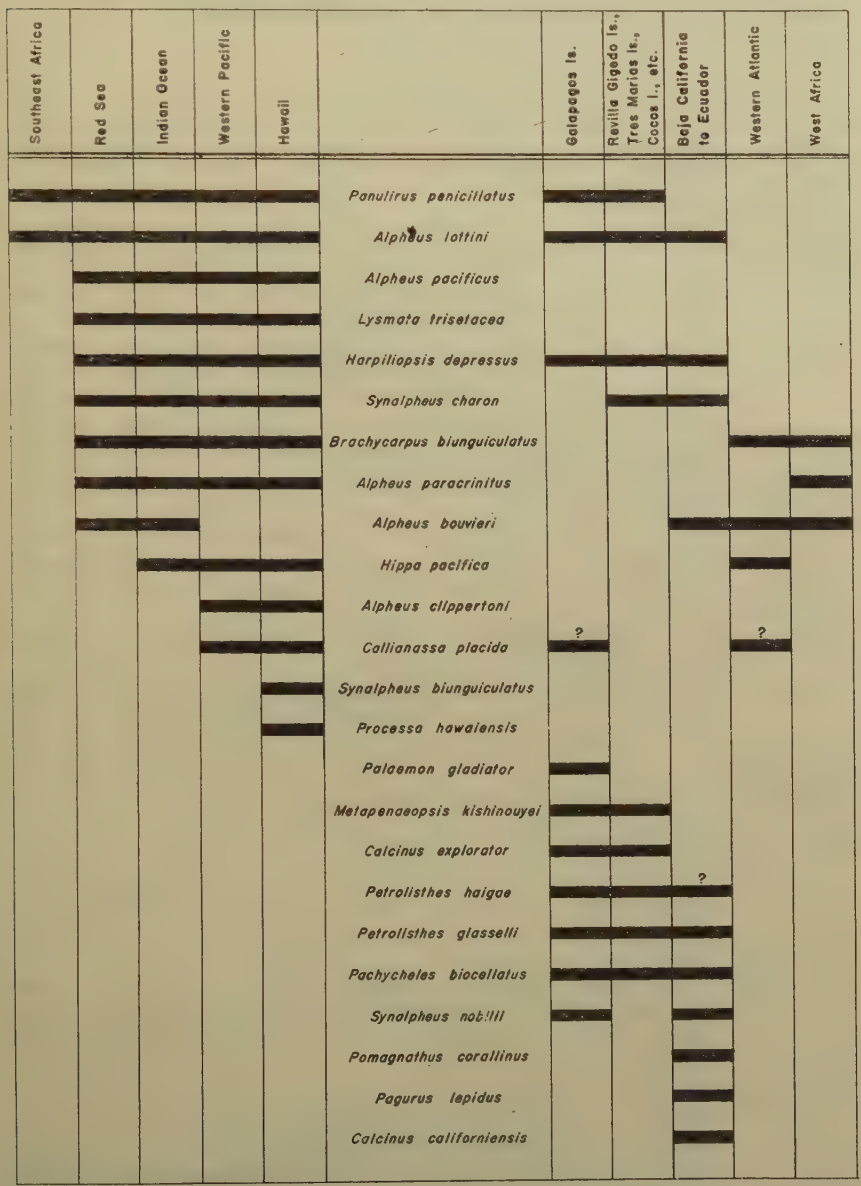

FIGURE 7.—Geographic distribution of the non-brachyuran decapod crustaceans of Clipperton Island.

none of the 10 species that are known only from the eastern part of the Pacific have been recorded from the Atlantic. Such evidence, limited and incomplete though it is, suggests that one of the most important barriers to the pantropical distribution of the non-brachyuran decapods is the American land mass, combined with the absence of suitable island stepping stones in the eastern Pacific.

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